

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE	3. REPORT TYPE AND DATES COVERED FINAL	
4. TITLE AND SUBTITLE Electron and Hole Transport in Compound Semiconductors			5. FUNDING NUMBERS 61102F 2305/FS	
6. AUTHOR(S) Dr Shur				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Univ of Virginia Charlottesville, VA 22903-2442			8. PERFORMING ORGANIZATION REPORT NUMBER AFOSR-TR-95-0308	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NE 110 Duncan Avenue Suite B115 Bolling AFB DC 20332-0001			10. SPONSORING/MONITORING AGENCY REPORT NUMBER F49620-92-J-0393	
11. SUPPLEMENTARY NOTES				
12. DISTRIBUTION AVAILABILITY STATEMENT APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED			12a. DISTRIBUTION CODE DTIC SELECTED JUN 21 1995 F	
13. ABSTRACT SEE FINAL REPORT ABSTRACT 19950616 081 DTIC QUALITY INSPECTED 5				
14. SUBJECT TERMS			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UNCLASSIFIED	

Contract # F49620-92-J-0393

Principal Investigator : Michael Shur

Electron and Hole Transport in Compound Semiconductors

Final Report to the US Air Force .

Authors : Boris Gelmont, Bjornar Lund, Michael Shur

We investigated transport properties of InSb and GaSb. We implemented an algorithm for electron-electron scattering in the Monte Carlo simulator, and used this simulator to study the effect of electron-electron scattering at relatively low electric fields. We also developed a program for the calculation of the electron velocity and electron temperature as functions of an electric field. This calculation was based on the moment and energy balance equations. We applied this program to study the heating and drift velocity of electrons in InSb. This method is less time-consuming than the Monte Carlo method and more suitable for the implementation in device simulators. We have also calculated numerically the low-field mobility due to acoustic and optical phonons, obtaining excellent agreement with our Monte Carlo simulations. Based on these studies, we wrote a program for the calculation of mobilities in all cubic semiconductors and their alloys. The program assumes spherical bands, but accounts for carrier degeneracy, non-parabolicity, and varying screening length. (It can be easily modified to account for non-parabolicity.)

The program calculates mobility for the following scattering mechanisms:

A) Γ -valley electrons:

- 1) polar optical scattering
- 2) acoustic (deformation potential) scattering
- 3) piezoelectric scattering
- 4) ionized impurity scattering, with and without Ridley modification
- 5) alloy scattering
- 6) intervalley scattering to L-valley

B) L-valley electrons:

- 1) polar optical scattering
- 2) acoustic (deformation potential) scattering
- 3) piezoelectric scattering
- 4) ionized impurity scattering, with and without Ridley modification
- 5) alloy scattering
- 6) intervalley scattering between L-valleys
- 6) intervalley scattering to Γ -valley

*any comments?
software?*

We calculated mobilities for the temperature range 20 K to 80 K and drift velocity versus electric field for electrons in InSb at 77 K. For this compound, the calculations were limited to the values of electric field such that the carriers are confined to the central Γ -valley and no impact ionization occurs. The optical phonon scattering calculation at 77 K was based on a new approach valid for thermal energy smaller than the polar phonon energy. We first developed this approach for wide band gap semiconductors and then we modified it for narrow gap materials taking into account non-parabolicity of the electron dispersion law.

This calculation does not assume a displaced Maxwellian distribution function, and the result is in excellent agreement with our Monte Carlo simulations.

We also considered the theory of polar optical mobility in two-dimensional electron gas and derived equations which allowed us to calculate this mobility in the case when intersubband transitions are negligible.

In GaSb intervalley scattering from the Γ -valley to L-valley as well as between the equivalent L-valleys has to be taken into account in the calculation of the low-field mobility. We also developed a similar approach for intervalley scattering between both equivalent and nonequivalent valleys. We obtained a good agreement with experimental data.

Submitted for publication:

B. Gelmont, M. Shur, and M. Strosio, "Polar Optical Phonon Scattering in Three and Two Dimensional Electron Gases", submitted to J. Appl. Phys.

B. Gelmont, B. Lund, and M. Shur, "Analytical Theory of Low Field Transport in GaSb", in preparation

Accession For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	